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TECHNICAL REPORT

TR-76-56-FEL

**AN UPDATE STUDY OF DISPOSABLE VS PERMANENT
MESS GEAR ON BOARD NAVY SHIPS**

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June 1976

**UNITED STATES ARMY
NATICK RESEARCH and DEVELOPMENT COMMAND
NATICK, MASSACHUSETTS 01760**



**Food Engineering Laboratory
FEL-50**

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The purpose of this report is to update a 1968 technical report (1) and a complementary 1969 technical report (2) on the feasibility of substituting disposable mess gear for permanent mess gear on board Navy ships. Both prior reports found that a disposable mess gear system for Navy ships appears feasible, practical, and cost effective, and should reduce manpower costs by eliminating scullery personnel.		

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This update report does not support the findings of the 1968 and 1969 reports. New factors which contribute to this change are:

a. Rapidly rising costs of petrochemicals, in this case polystyrene, used for disposables.

b. Current Navy policy on waste reduction and disposal and environmental protection.

c. New evidence that a disposable ware system does not necessarily reduce overall labor costs, has no sanitation advantage over a well-operated permanent ware system, and is not generally preferred by users over an attractive permanent ware system.

The previous two reports compared two alternatives: The present permanent mess gear system VS a proposed disposable mess gear system. This update report adds a third alternative -- a future improved permanent mess gear system, and concludes that this third alternative is the way to go.

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	<u>PAGE</u>
TABLE OF CONTENTS	
List of Illustrations	3
List of Figures	3
List of Tables	3
I. INVESTIGATION	
A. Introduction	4
B. Rationale of this Update	4
C. Description of Permanent and Disposable Mess Gear Systems	4
(1) Permanent	4
(2) Disposable	5
D. General Data on Disposable Mess Gear	
(1) A Place for Disposables	5
(2) Sanitation	5
(3) Biodegradable Plastics	5
(4) Waste Disposal Part of Cost of Using a Material	13
(5) Disposable Items as Percentages of Weight, Volume, and Cost	13
E. Problems in Adopting Disposable Mess Gear	
(1) Rising Costs of Disposables	13
(2) Comparative Costs: Permanent Ware vs Disposable Ware	13
(3) Cost of Incinerator Disposal of Disposables	13
(4) Logistics of Disposables and Ships Endurance	14
(5) Storage Space for Disposables	14
(6) Disposables as 100% Subsistence Waste	15
(7) Disposables in Conflict with Current Navy Policies	15

TABLE OF CONTENTS (CONT'D)

	<u>PAGE</u>
a. Waste Reduction and Disposal	15
b. Environmental Pollution	15
c. Instructions for Survey of Refuse Generated Aboard Navy Vessels	15
F. Advantages of a Permanent Mess Gear System	
(1) Cost	16
(2) Navy Policies	16
(3) Endurance Constriction	16
(4) Storage Space	16
(5) User Preference	16
(6) Sanitation	16
G. Proposed Third Alternative -- An Improved Permanent Mess Gear System	16
II. CONCLUSIONS	18
III. RECOMMENDATION	18
References	19
Appendix A	21
Appendix B	22
Appendix C	24
Appendix D	26

LIST OF ILLUSTRATIONS

1. Scullery -- USS America	28
2. Scullery -- USS America	29

LIST OF FIGURES

Figure 1 -- Disposable Mess Gear Weight	10
Figure 2 -- Disposable Mess Gear Volume	11
Figure 3 -- Disposable Mess Gear Cost	12

LIST OF TABLES

Table 1 -- Volume, Weight, Cost Per Man - Day: Disposable Mess Gear	6
Table 2 -- Comparative Yearly Cost: Present Permanent vs Proposed Disposable Mess Gear	7
Table 3 -- Trip Total Cost & Cost Per Man - Day: Disposable Mess Gear	8
Table 4 -- Prices of Plastic Disposables	9

I. INVESTIGATION

A. Introduction: This update study was undertaken in response to the US Navy Requirement 5-5 to update two technical reports: "Disposable Mess Gear Study Under DXGM Cost Reduction Program" (1) and "Report of Disposable Mess Gear Test Conducted at Charleston Naval Shipyard, Charleston, South Carolina." (2).

The 1968 study, reference (1), was conducted to determine the feasibility of using disposable mess gear on board ship. The finding was positive.

The 1969 study, reference (2), was conducted to determine the acceptability of plastic mess gear by Navy personnel and the feasibility of incinerator disposal. Both findings were positive, with some reservations.

However, both studies omitted the high costs of the installation, operation, and maintenance of an incineration system (to dispose of the disposables) necessitated by the 100% waste disposal system - as compared to the 5% - 10% (breakage) waste of a permanent ware system.

B. Rationale of this Update: Since Navy ships will always have galleys, they will always have sculleries to wash the soiled pots, pans, other cooking utensils, and serving trays. Also, since Navy ships produce large quantities of waste (more than 3-pounds per man per day) they will always have incinerators, or equivalent, to conform to current Navy policy which forbids the jettisoning of polluting wastes.

Obviously, a disposable mess gear system will require a larger incinerator system and a smaller scullery system; and a permanent ware system will require the reverse.

In summary, Navy ships - except very small ones - will always have a scullery system of some kind, and an incinerator system of some kind, regardless of whether the mess gear system is disposable or permanent.

C. Description of Permanent and Disposable Mess Gear Systems:

(1) Permanent: The present permanent mess gear system is composed of a stainless steel 6-compartment tray, china coffee cup, china soup bowl, and stainless steel cutlery. The estimated yearly cost for 437-men is \$45,795, or \$50,695 if disposable cups are provided for use between meals (Table 2). The present cost per man per day is \$0.37 (Table 3).

(2) Proposed Disposable Mess Gear System: The proposed disposable mess gear system includes:

a. A disposable cup, bowl, night ration/battle plate, and cutlery (Tables 1 and 3) - all of polystyrene, with either:

b. A permanent flat tray with a disposable 6-compartment flexible polystyrene liner. The yearly cost of "a" and "b" is \$63,418 (Table 2). The present cost per man per day is \$0.58 (Table 3).

The 1968 and 1969 Technical Reports, of which this Report is an update, recommended the "a" and "b" combination, above.

D. General Data on Disposable Mess Gear.

(1) A Place for Disposables: A disposable mess gear system is a must for take-out services like McDonald's Hamburger. To a lesser extent, this may also be true for those sections of hospitals where patients with communicable diseases are treated, and for disposing of hospital pathological wastes. Disposables, rather than permanent mess kits may even be feasible and cost effective in some military situations (e.g., epidemics; war-games) for soldiers in the field. But there is no empirical evidence that disposable mess gear is suitable for Navy ships.

(2) Sanitation: According to the US Department of Health, Education, and Welfare - Public Health Service, (3) a disposable mess gear system has no sanitation advantage over a permanent ware system employing a good, properly-operated, mechanical dishwashing machine:

"Proper dishwashing procedures are considered adequate for disinfecting dishes"; (3) and "Since food and drink service items from all patients and hospital personnel must be sanitized after each use, it is important that mechanical dishwashers meet appropriate performance standards. In addition, procedures must provide for the proper use of such equipment." (3).

(3) Biodegradable Plastics: A thorough search failed to disclose any new materials, such as biodegradable plastics, to take the place of polystyrene in the manufacture of disposable mess gear. (4) Molded pulp (wood fiber), which is competitive with polystyrene, can be used instead of polystyrene for some disposables, but not for coffee cups or cutlery. Unlike polystyrene, wood pulp can be incinerated without producing poisonous vapors or damaging the incinerator.

TABLE I: VOLUME, WEIGHT, COST PER MAN-DAY --- DISPOSABLE MESS GEAR
(Endurance: 437 Men for 75 Days)

ITEM	RECOMMENDED TYPE	PER 1,000 UNITS			COST PER MAN-DAY ^a	75-DAY LOAD	
		WEIGHT	VOLUME	PRICE		WEIGHT	VOLUME
TRAY LINERS	Compartmented Liners --- Solid Polystyrene	100 lbs. (45.36 kg)	4.30 ft. ³ (0.12 m ³)	\$59.00	\$0.177	9,800 lbs. (445.28 kg)	420. ft. ³ (11.89 m ³)
CUPS	8 oz. (226.80 g) Low-Density Polystyrene Foam	16.0 lbs. (7.26 kg)	3.97 ft. ³ (0.11 m ³)	10.90	0.087	4,700 lbs. (2131.92 kg)	1,048 ft. ³ (29.68 m ³)
BOWLS	12 oz (340.20 g) Solid Polystyrene	22.0 lbs. (9.98 kg)	1.95 ft. ³ (0.05 m ³)	22.73	0.045	1,323 lbs. (600.11 kg)	131 ft. ³ (3.71 m ³)
FLATWARE	Polystyrene Injection Moulded	13.0 lbs. (5.90 kg)	0.50 ft. ³ (0.01 m ³)	8.74	0.079	3,835 lbs. (1739.56 kg)	147 ft. ³ (4.16 m ³)
NIGHT RATION BATTLE PLATES	Oval 5 3/4" x 7 7/8" (14.61 cm x 20.00 cm)	20.0 lbs. (9.07 kg)	4.00 ft. ³ (0.11 m ³)	30.26	0.010	260 lbs. (117.94 kg)	52 ft. ³ (1.47 m ³)
TOTAL					0.398	19,918 lbs. (9034.80 kg)	1798 ft. ³ (50.91 m ³)

a. Costs expressed in manufacturer' catalog prices

TABLE 2: COMPARATIVE YEARLY COSTS (1975) - PRESENT PERMANENT vs PROPOSED DISPOSABLE MESS GEAR

	COST PER YEAR (437 ENLISTED MEN)		
	PRESENT (PERMANENT)	PROPOSED (TRAY LINERS)	ALTERNATE (DISPOSABLE TRAYS)
1. Manpower - 4.2 Men ^e at \$9,600 per Year (Estimated 1975 Cost)	\$40,320	\$N/A	\$N/A
2. Permanent Mess Gear Breakage, Detergent and Hot Water Consumption	1,265	600	N/A
3. Disposable Cups at Five per Man per Day (Between Meals, where applicable)	4,900 ^a	N/A	N/A
4. Dishwasher Depreciation, Maintenance, Trash Removal in Port, Hot Water	4,210	N/A	N/A
5. Cost of Disposable Mess Gear at \$0.40 per Man per Day, with Liners; \$0.58 ^b per Man per Day with Disposable Trays	N/A	49,818	72,236
6. Manpower - 1-Man at \$9,600/Year; Incinerator Depreciation & Maintenance; Cost of Fuel and Hot Water	N/A	13,000	12,600
7. Totals	(50,695) (45,795)	63,418	84,836
Total Loss per Year Using Liners -- (Proposed Disposable Mess Gear Minus Present Permanent Mess Gear)	\$12,723 ^c	\$17,623 ^d	

- Some ships now use disposable cups between meals.
- Formula for computation is shown in Appendix A.
- $\$63,418 - \$50,695 = \$12,723$.
- $\$63,418 - \$45,795 = \$17,623$.
- See Prior Study, Reference (1).

TABLE 3: TRIP TOTAL COST & COST PER MAN PER DAY - DISPOSABLE MESS GEAR
AND PERMANENT MESS GEAR
(ENDURANCE: 437 MEN FOR 75-DAYS)

RECOMMENDED UTENSIL	COST PER THOUSAND (\$)	TOTAL QUANTITY REQUIRED (THOUSANDS)	TOTAL COST (\$)
Disposable Tray (or) Disposable Liner	120.00 (or) 59.00	98.3 (or) 98.3	11,796 (or) 5,800
Bowl	22.73	65.5	1,489
Cup	10.90	262	2,856
Cutlery	8.74	295	2,578
Night Ration/Battle Plates	30.26	13	<u>393</u>
With Disposable Tray:			19,112
With Disposable Liner:			13,116
TRIP TOTAL COST (WITH DISPOSABLE TRAY)			(\$) 19,112
COST PER MAN PER DAY	$\frac{19,112}{75 \times 437}$	=	0.58
TRIP TOTAL COST (WITH DISPOSABLE LINER & PERMANENT TRAY)			13,116
COST PER MAN PER DAY	$\frac{13,116}{75 \times 437}$	=	0.40
TRIP TOTAL COST (WITH PERMANENT MESS GEAR)			
$\frac{75 \times 45705 \text{ (TABLE 2)}}{285 \text{ (APPENDIX A)}}$			= 12,028
COST PER MAN PER DAY	$\frac{12,028}{75 \times 437}$	=	0.37

TABLE 4

PRICES OF PLASTIC DISPOSABLES (PER THOUSAND)

ITEM	YEAR		PERCENT INCREASE
	1968	1976	
12" x 15" (30.48 cm x 38.10 cm) TRAY LINER, SOLID POLYSTYRENE	\$40.00	\$59.00	47.5
CUP, 9 oz (255.15 g) HOT & COLD, LOW DENSITY POLYSTYRENE FOAM	9.75	10.90	12.0
BOWL, 12 oz (340.19 g), POLYSTYRENE	16.00	22.73	42.0
CUTLERY, SOLID POLYSTYRENE	6.10	8.74	43.0
NIGHT RATION/BATTLE PLATES	25.98	30.26	17.0

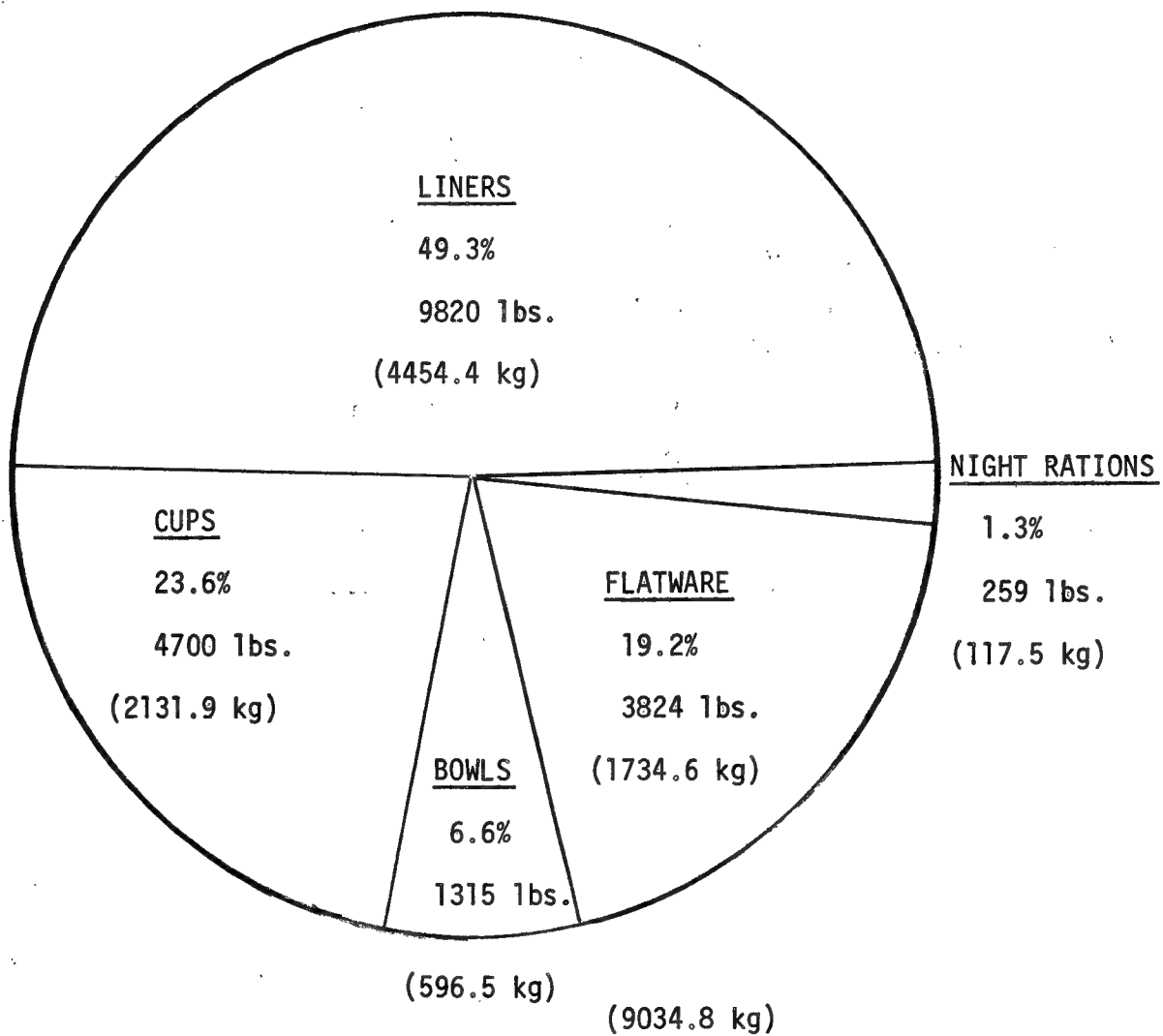


FIGURE 1: DISPOSABLE MESS GEAR WEIGHT 19,819 LBS. (FROM TABLE 1).
(437 MEN FOR 75 DAYS)

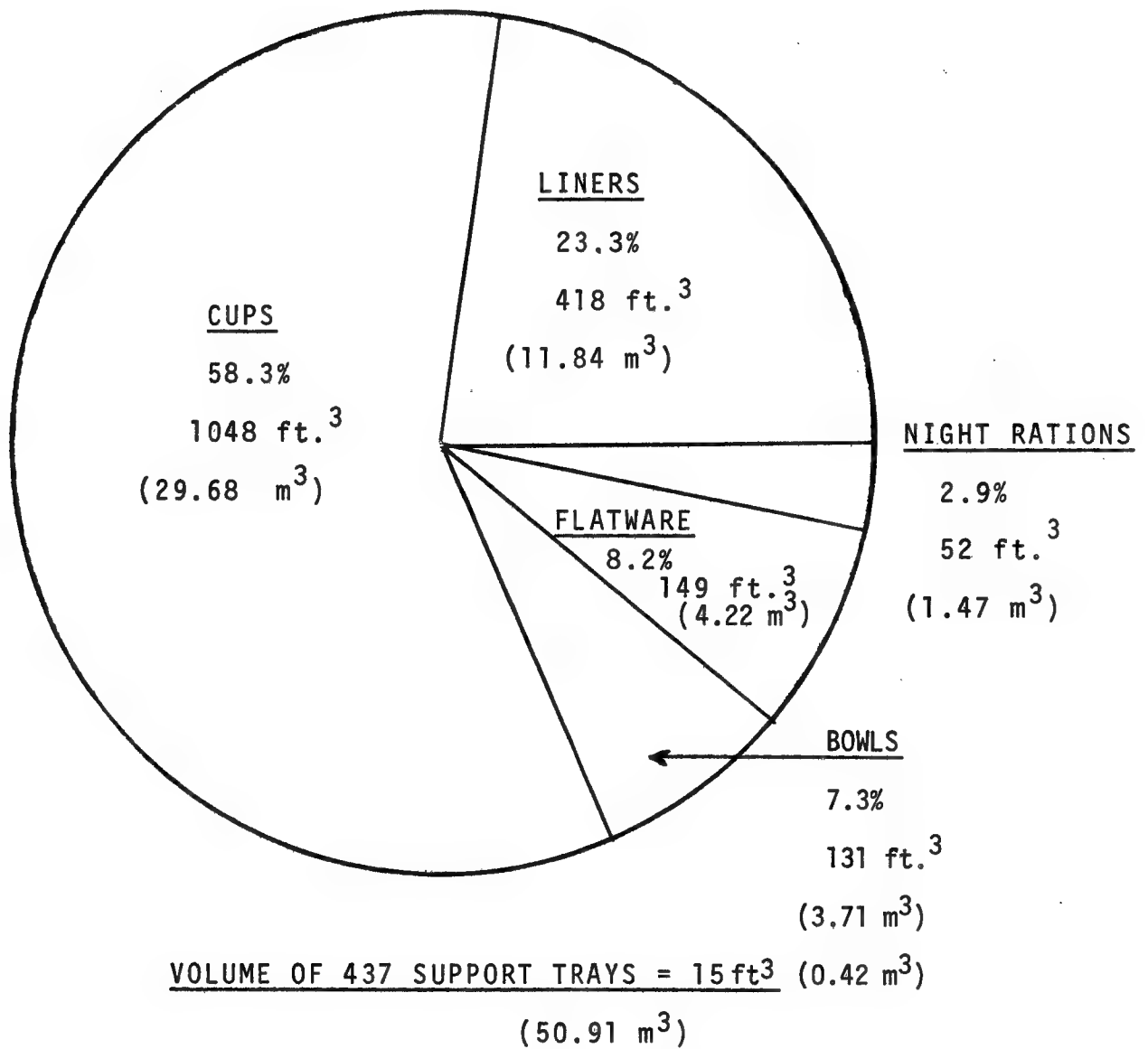


FIGURE 2: DISPOSABLE MESS GEAR VOLUME 1798 ft.³ (From Table 1) .
(437 MEN FOR 75 DAYS)

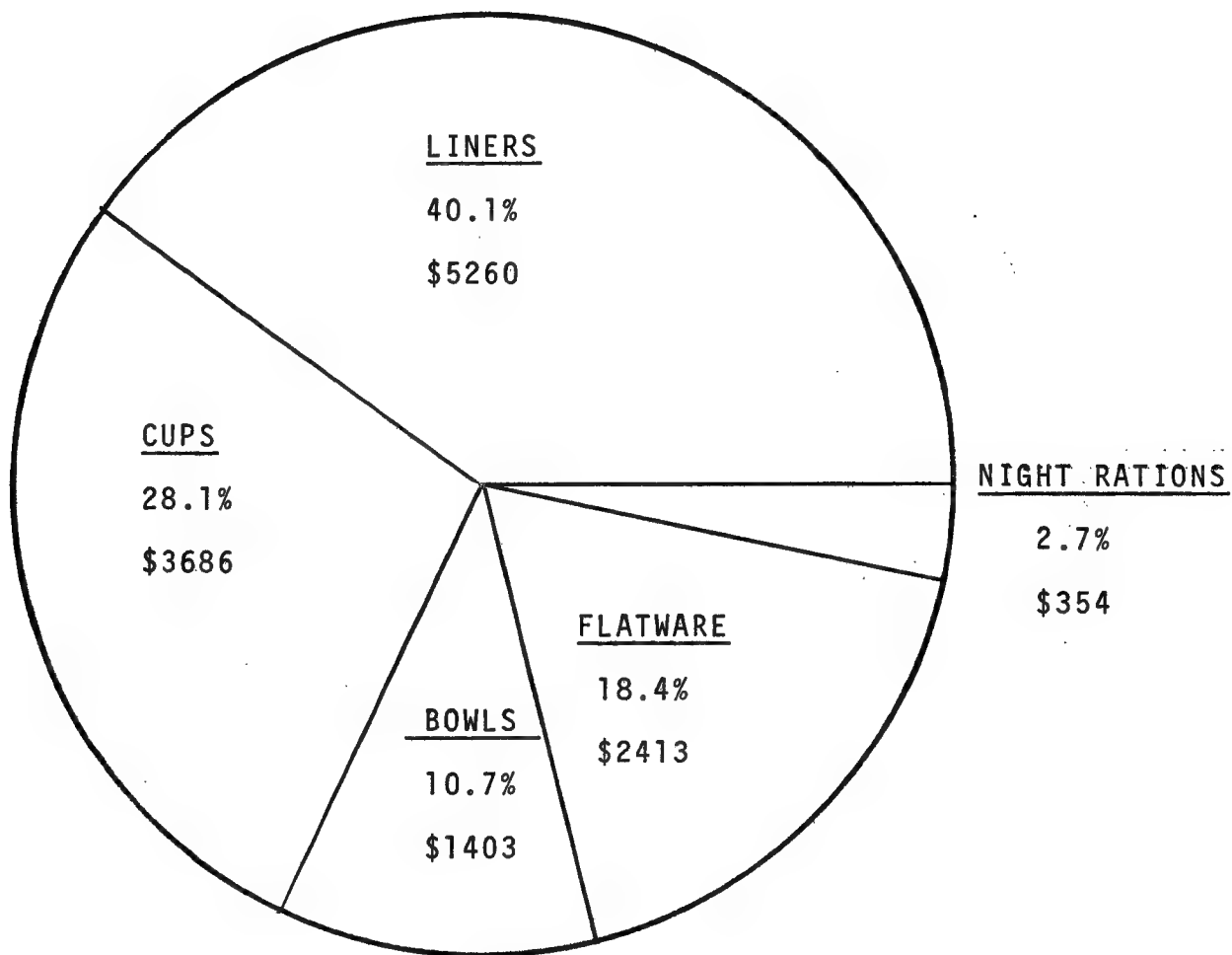


FIGURE 3: DISPOSABLE MESS GEAR COST \$13,116 (FROM TABLE 3).
(437 MEN FOR 75 DAYS)

(4) Waste Disposal Part of Cost of Using a Material. The high cost of ecologically acceptable disposal of non-biodegradable waste will henceforth be part of the cost of using these materials, i.e., part of the cost of "doing business". This is one reason a 5% - 10% waste system (breakage) like permanent mess gear is almost necessarily less costly in the long term than a 100% waste system like disposable mess gear.

(5) Disposable Items as Percentages of Weight, Volume, and Cost. Figures 1, 2, and 3, respectively, show each item of disposable ware as a percentage of total weight, total volume, and total cost, for a ship's endurance of 437 men for 75 days. Tray liners account for the greatest percentage of weight (49.3%) and cost (40.1%), and cups account for the greatest percentage of volume (58.3%).

E. Problems in Adopting Disposable Mess Gear.

(1) Rising Costs of Disposables: Costs of polystyrene disposables have risen an average of 32.3% in the 8-year period since 1968 (Table 4). These sharp price increases are expected to continue due to the growing scarcity of petrochemicals.

(2) Comparative Costs: Permanent Ware vs Disposable Ware. The long-term cost of a permanent ware system for a 437 man Navy ship is less than that of a disposable ware system - see Table 2. Note that the major yearly cost of disposable ware is scullery labor (\$40,320), whereas the major yearly cost of disposable ware is the ware itself (\$49,818), followed by incinerator labor (\$9,600).

The findings of previous (commercial) research on the comparative cost of permanent ware vs disposable ware are: A doctoral thesis (5) found that the permanent ware system was less costly for a hospital food service; eight published studies by the accounting firm Laventhol Krekstein Horwath and Horwath (6) for the Permanent Ware Institute found that permanent ware was less costly for 8 specific applications - one reproduced here as Appendix C; two unpublished studies by the Single Service Institute found that disposable ware was less costly for two specific applications.

(3) Cost of Incinerator Disposal of Disposables. A thorough review of the present legal means of disposal of plastic mess gear from Naval vessels was made, such as densification (refuse is compressed until it has a negative buoyancy, then jettisoned) and incineration. Incineration still appears to be the best means of disposal in 1976 as it was in 1968 (1).

The major advantages of incineration include: (7)

- a. Incineration produces a sterile ash which can be packaged to give it negative buoyancy, and jettisoned.
- b. It reduces bulk to 5 to 10 percent of the original volume.
- c. It treats waste rapidly, and soon after generation.

The major disadvantage of incineration is the high cost of equipment installation, operation, and maintenance. It is estimated that the initial cost of an incinerator and accessory equipment for a 400-500 man ship is \$50,000, and labor to operate and maintain this system is about \$9,600 per year on the basis of an 8-hour shift and 5-day week for one man.

(4) Logistics of Disposables and Ship's Endurance. Warships must carry a supply of disposables with them. The greater the ship's endurance the larger the supply space required, i.e., as ship space becomes more valuable with increasing endurance, the more space is required for disposables storage (see Figure 2). This is not true for permanent mess gear; the scullery size does not increase with a ship's endurance. Therefore, disposables tend to generate an additional, unnecessary constraint on the endurance of warships. Caches of disposables throughout the world are impracticable.

(5) Storage Space for Disposables. Storage space for disposables increases directly with a ship's endurance, and can exceed the scullery space, which is also required for a disposable ware system (see paragraph 1B). An endurance of 437 men for 75 days requires 1798 cubic feet (50.9 m³) of storage space for disposable mess gear (Table 1). Assuming a 70% utilization of storage space and a 6.5 feet (2.0 m) stacking height, the volume required is:

$$\frac{1798 \text{ ft.}^3}{0.7} = 2569 \text{ ft.}^3 \quad (72.75 \text{ m}^3) \quad (1)$$

The floor area required is:

$$\frac{2569 \text{ ft.}^3}{6.5 \text{ ft.}} = 395.23 \text{ ft.}^2 \quad (36.7 \text{ m}^2) \quad (2)$$

That is, a 20 ft x 20 ft = 400 sq. ft. room (6.1 m x 6.1 m = 37.2 m²) would be required to store disposables for 437 men for 75 days; a larger floor area than that required for the ship's scullery, which is also required to wash the soiled pots, pans, other cooking utensils and serving trays.

(6) Disposables as 100% Subsistence Waste: Navy ships generate large quantities of refuse; 3.04 pounds (1.38 kg) per man per day (Appendix D) of which 1.61 pounds (0.73 kg) or 53%, is subsistence waste:

$$\frac{1.61}{3.04} = 53\% \text{ subsistence waste} \quad (1)$$

A disposable mess gear system for 437 men for 75 days generates an additional 20,000 lbs. (9072 kg) of subsistence waste (Table 1), or:

$$\frac{20,000}{437 \times 75} = 0.61 \text{ lbs (0.28 kg) per man per day.} \quad (2)$$

additional subsistence waste.

$$\frac{1.61 + 0.61}{3.04 + 0.61} = \frac{2.22}{3.65} = 61\% \text{ subsistence waste.} \quad (3)$$

61% - 53% = 8% Rise; i.e., disposable mess gear increases subsistence waste by 8%.

(7) Disposables in Conflict with Current Navy Policies: Disposable mess gear for Navy ships is in conflict with current Navy policies on waste reduction and environmental pollution, as defined below:

a. Waste Reduction and Disposal: "Navy policy is to reduce the amount of material to be disposed of, and to dispose of necessary waste with minimum adverse ecological effect." (8).

b. Environmental Pollution: "... The preferred method for abatement and control of environmental pollution is at the source of the pollutants. Therefore, environmental pollution prevention shall be integrated into any planned industrial process, operation, or product, and be considered as part of the cost of "doing business." (9)

c. Instructions for Survey of Refuse Generated Aboard Navy Vessels: "Background information: Except as prohibited by current legislation or executive orders, or for security reasons, US Naval vessels operating on the high seas away from land areas routinely discharge overboard their daily accumulated waste matter. Pending and expected Government legislation and orders relative to environmental pollution control will severely limit and eventually prohibit these discharges. Additionally, to improve public relations and promote goodwill, the Navy should be a leader in efforts to alleviate growing public concern with the

negative effects of floating refuse that may be washed to coastal areas of the US and other countries. Therefore, the Chief of Naval Operations has requested the Chief of Naval Materiel to conduct a study of refuse disposal aboard naval vessels at sea and when berthed and to make recommendations for methods to improve disposal." (10)

F. Advantages of a Permanent Mess Gear System.

A permanent mess gear system has a favorable effect on factors (1) to (4), inclusive, and a neutral effect on factors (5) and (6), below.

(1) Cost: The yearly cost of a permanent mess gear system is less than that of a disposable mess gear system (see paragraphs IA, IE(3), AND Table 2).

(2) Navy Policies: In accordance with current Navy policies, a permanent mess gear system produces little waste and has a minimum adverse ecological effect - see Paragraph IE(7).

(3) Endurance Constriction: Permanent mess gear does not tend to constrict a ship's endurance as does disposable mess gear - see paragraph IE(4).

(4) Storage Space: Permanent mess gear requires less storage space than disposable mess gear - see paragraph IE(5).

(5) User Preference: There is no empirical evidence that disposable mess gear is preferred by users. The best hotels, restaurants, and most residences, use permanent ware.

(6) Sanitation: There is no empirical evidence that permanent mess gear is less sanitary than disposable mess gear - see paragraph ID(2).

G. Proposed Third Alternative - An Improved Permanent Mess Gear System.

The 1968 (1) and 1969 (2) studies compared two alternatives - the present permanent mess gear system and a proposed disposable mess gear system. This update study proposes a third alternative - an improved permanent mess gear system for Navy ships.

Navy nonrated men are often assigned to food service work, including Kitchen Police (KP) work in the ship's scullery. On some ships this assignment lasts for 90-days, but the same men are not assigned to the scullery again after the 90-days are over.

KP work in the scullery, which undoubtedly lowers morale, could be made more bearable by improving scullery design; "human engineer" the scullery, so to speak, as an effective complement to equipment systems which are geared for high productivity.

The initial approach to the room itself must be made with the idea that people are going to work here and both their productivity and morale will be greatly influenced by their surrounding (see illustrations, pages

Many of the disagreeable aspects of scullery work tend to disappear when more productive designs are placed in a scullery that has ample floor area, controlled temperatures, good ventilation, wall and floor surfaces that are easily maintained, effective lighting, smooth traffic flow, and low noise levels.

II. CONCLUSIONS

This update study concludes:

A. That a disposable mess gear system is more costly than a permanent mess gear system; is in conflict with Navy waste reduction and environmental protection policies; tends to constrict the endurance of a warship; requires more storage space than a permanent mess gear system; is not necessarily preferred by users over a good permanent ware system, and is not necessarily more sanitary than a permanent ware system (see paragraph IF).

B. That a permanent mess gear system, improved as outlined in paragraph IG, above, and as detailed in paragraph III, below, is the way to go.

III. RECOMMENDATIONS

It is recommended that, where applicable, one or more of the manual scullery operations be automated to upgrade the habitability of the scullery. Recommended equipment development is as follows:

1. An automatic means of transferring soiled trays from cart to dishwasher conveyor.
2. An automatic means of paper removal from trays.
3. Automated equipment for washing, drying, and stacking trays, after removal of soiled dishes.
4. Automatic removal, washing, and drying of silverware.
5. An automatic means of silverware sorting.
6. An automatic dish sorter.

It is suggested that these six operations be given consideration for future development contracts. For planning and budgeting purposes, we estimate that between one and two years of professional engineering and practical support effort would be required for research, engineering, development, and testing of each of these six projects.

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APPENDICES A, B, C, & D

APPENDIX A

FORMULA FOR ANNUAL COST OF DISPOSABLE MESS GEAR

Y - Annual Cost of Disposable Mess Gear.

d - Daily Cost of Mess Gear per Man.

N - Number of Men.

.94 N - Number of Men Served at Sea.

.70 N - Number of Men Served in Port.

$1/3 \times 365$ - Estimated Days at Sea.

$2/3 \times 365$ - Estimated Days in Port.

Cost at Sea - $1/3 \times 365 \times .94 \times d \times N = 115 \text{ dN}$.

Cost in Port - $2/3 \times 365 \times .70 \times d \times N = 170 \text{ dN}$.

Annual Cost of Disposable Mess Gear: $Y = 115 \text{ dN} + 170 \text{ dN}$.
 $= 285 \text{ dN}$.

APPENDIX B

GUIDELINES FOR COST COMPARISON --- DISPOSABLE WARE VS PERMANENT WARE (SEE REF. 11)

NOTE: Prorate Annual and Monthly Costs for 7-Day Period for Both Permanent Ware and Disposable Ware.

I. To Determine True Cost of Using Permanent Ware, include:

- A. Cost of machinery and equipment and related costs.
 - (1) Depreciation (useful life of 15 years is average).
 - (2) Repairs and maintenance.
 - (3) Utility costs (electricity and water).
- B. Replacement costs of permanent ware.
- C. Interest on capital investment.
- D. Labor costs, including employee benefits (only hours actually spent on warewashing tasks).
- E. Cost of warewashing supplies (Include only costs of materials actually used in dish room. Do not include costs of washing pots and pans, or housekeeping costs.)
- F. Cost of Refuse and Garbage Removal. (You will need to know the average number of utensils per patron, including tray, for the 7-Day period, and also the total number of meals.)

II. To Determine True Costs of Using Disposables, include:

- A. Cost per thousand of each item to be used.

This cost must be based on quantity price you will be ordering --- keep size of store room in mind.

- B. If permanent tray is used, and washing machine is used:

Cost of machinery and equipment and related costs as established in paragraph I.A., above. To proportion this prorated cost, determine number of disposable items used during 7-day period, average per tray. Example: 6 disposables plus tray equals $\frac{1}{7}$ of above prorated cost; 7 disposables plus one tray equals $\frac{1}{8}$; 4 disposables plus 3 silverware plus one tray equals $\frac{4}{8}$, etc.

APPENDIX B (Cont'd)

- C. Interest on capital investment.
- D. Estimate space necessary for storage of monthly needs of disposables, and multiply by cost per square foot of ship storage space.
- E. Cost of refuse and garbage removal.
 - (1) Volume with disposables.
 - (2) Project to number of pickups per year.
 - (3) Cost per pickup.
- F. Labor costs, including employee benefits.
 - (1) Time stripping trays; depositing refuse in dumpster; moving dumpster; moving dumpster to garbage pickup area; returning dumpster to stripping area.
 - (2) If permanent trays are used, include time spent setting up dishmachine (or sinks); washing trays and returning them to point of service; clean-up of area.
 - (3) Time spent unpacking cases of disposables and stacking in area of service.
 - (4) Time spent reordering, receiving, and placing in storeroom.
- G. Cost of tray-washing supplies (if permanent trays are used).
- H. Number of disposable utensils per person (plus number of permanent ware items, such as trays).
- I. Closing inventory of disposables.
- J. Replacement costs of permanent trays.

APPENDIX C

COMPARATIVE COST OF DISPOSABLE VERSUS PERMANENT WARE (SEE REF. 6)

(Conducted at the Purdue Memorial Union Food Service, West Lafayette, Indiana)

The Purdue Memorial Union is the center of student activities at Purdue University. It has a large multi-unit food service facility that served more than one million meals last year.

This study was conducted by the accounting firm of Laventhol Krekstein Horwath & Horwath during two five-day periods in July-August, 1968.

During the first five-day period, permanent ware -- china, glass, and silverware -- was used. In the second period, three weeks later, disposable ware was used, except for permanent cafeteria trays used during both research periods.

The test area consisted of two double-line cafeterias located on opposite sides of a 1,757 square foot warewashing room, plus an additional counter in a separate area.

PHASE ONE - PERMANENT WARE

Machinery, equipment and related costs constituted one of the major components of the study. Major warewashing equipment consisted of: Dishwashing machine, glasswashing machine, silverwashing machine. This equipment is depreciated over a 15-year period. Annual repairs and maintenance cost amounted to \$896.

Related costs included utility charges and costs of detergent and dishwashing compound. Total annual costs for warewashing equipment were \$9,279.

Annual replacement cost of chinaware, glassware, and silverware amounted to \$5,671.

Other cost factors included in the study were annual interest on capital investment of machinery and equipment -- \$1,523; labor costs and employee benefits during five-day study period -- \$579; and annual refuse and garbage removal costs -- \$1,965.

PHASE ONE CONCLUSIONS

During the five-day test period in which permanent ware was used, an average of 7.03 utensil pieces were used per meal at a usage cost of 0.85 cents per utensil or 6 cents per meal ($7.03 \times 0.85 = 6$).

APPENDIX C (Cont'd)

PHASE TWO -- DISPOSABLES

The costs for machinery, equipment, and related costs for this phase of the study were calculated on the assumption that a smaller warewashing machine, for use with cafeteria trays only, would be needed. This annual cost was \$1,636.

Cost of disposable ware for the five-day test period was \$1,892. Annual interest on capital investment was \$345.

Labor costs and employee benefits were \$145. Tasks performed were:

1. Removing trays from moving belts and depositing disposables and leftover food in a portable refuse container.
2. Loading and unloading trays into and from the warewashing machine and stacking them for drying.
3. Filling flatware baskets and disposable flatware from bulk containers. Refuse and garbage removal increased 33% this test phase.

PHASE TWO CONCLUSIONS

An average of 7.1 utensil pieces were used per meal. Average usage cost was 1.2 cents, of 8.5 cents per meal ($7.1 \times 1.2 = 8.5$).

STUDY CONCLUSIONS

Based on the two test periods, the usage cost of disposable ware is 8.5 cents per meal, compared with a usage cost of 6 cents per meal for permanent ware.

APPENDIX D
TALLIED REFUSE GENERATION DATA SHEET - POUNDS/DAY
TOTAL GENERATED OVER ALL SHIPS

	SUB- SIS- TENCE	HOTEL/ ADMIN	MAINT/ REPAIR	ORDN- ANCE	MISC	MIXED	TOTAL	PERCENT
WOOD	TOT GEN ^a PER MAN	19.99 .04	85.61 .21	1.06 .00	1.37 .00	1.77 .00	111.33 .26	7.03
PAPER	TOT GEN PER MAN	133.87 .28	195.66 .41	.95 .00	30.91 .07	40.73 .07	434.31 .90	27.44
GLASS, CERAMIC	TOT GEN PER MAN	6.34 .01	1.82 .00	4.44 .01	.71 .00	1.38 .00	14.69 .03	.93
CLOTH	TOT GEN PER MAN	.48 .00	19.33 .03	26.61 .05	1.34 .00	1.48 .00	49.47 .09	3.13
METAL	TOT GEN PER MAN	63.56 .13	21.18 .03	76.40 .16	32.22 .06	8.68 .01	282.10 .52	17.82
RUBBER	TOT GEN PER MAN	.03 .00	.29 .00	3.87 .01	.17 .00	.02 .00	4.44 .01	.28
PLASTIC	TOT GEN PER MAN	1.94 .00	1.57 .00	2.32 .01	.92 .00	.27 .00	7.12 .01	8.45
COMPOS	TOT GEN PER MAN	.01 .00	.91 .00	4.89 .01	.80 .00	3.37 .00	9.98 .02	.63
OTHER	TOT GEN PER MAN	.69 .00	9.76 .02	16.86 .03	2.95 .00	.93 .00	31.29 .06	1.98
GARBAGE	TOT GEN PER MAN	634.95 1.14	1.07 .00	.42 .00	1.73 .00	.00 .00	638.17 1.14	40.32
TOT/DAY/SOURCE		861.87	253.12	253.60	82.53	73.11	1582.91	
PERCENT OF TOTAL BY SOURCE		54.45	15.99	16.02	5.21	4.62	100.00	
TOTAL/MAN/DAY		1.61	.50	.56	.14	.15	.09	3.04

^aTotal Generated

APPENDIX D

TALLIED REFUSE GENERATION DATA SHEET - KILOGRAMS/DAY TOTAL GENERATED OVER ALL SHIPS

	SUB- SIS- TENCE	HOTEL/ ADMIN	MAINT/ REPAIR	ORDN- ANCE	MISC	MIXED	TOTAL	PERCENT
WOOD	TOT GEN PER MAN	9.07 .02	38.83 .09	.48 .00	.62 .00	.80 .00	50.50 .12	3.19
PAPER	TOT GEN PER MAN	60.72 .13	14.60 .03	.43 .00	14.02 .03	18.47 .03	197.00 .41	12.45
GLASS, CERAMIC	TOT GEN PER MAN	2.88 .00	2.01 .00	.00 .00	.32 .00	.63 .00	6.66 .01	.42
CLOTH	TOT GEN PER MAN	.22 .00	12.07 .02	.10 .00	.61 .00	.67 .00	22.44 .04	1.42
METAL	TOT GEN PER MAN	28.83 .06	34.65 .07	36.31 .06	14.61 .03	3.94 .00	127.96 .24	8.08
RUBBER	TOT GEN PER MAN	.01 .00	1.75 .00	.03 .00	.08 .00	.01 .00	2.01 .00	.13
PLASTIC	TOT GEN PER MAN	.88 .00	1.05 .00	.03 .00	.42 .00	.12 .00	3.23 .00	.20
COMPOS	TOT GEN PER MAN	.00 .00	2.22 .00	.00 .00	.36 .00	1.53 .00	4.53 .01	.29
OTHER	TOT GEN PER MAN	.31 .00	7.65 .00	.04 .00	1.34 .00	.42 .00	14.19 .03	.90
GARBAGE	TOT GEN PER MAN	288.01 .52	.19 .00	.00 .00	.78 .00	.00 .00	289.47 .52	18.29
TOT/DAY/SOURCE		390.94	114.81	37.44	36.16	26.60	718.01	
PERCENT OF TOTAL BY SOURCE		24.70	7.25	2.36	2.10	1.68	45.36	
TOTAL/MAN/DAY		.73	.23	.25	.07	.04	1.38	

^aTOTAL GENERATED.



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